

# **Nutrient Optimization Report**

## **Colstrip, Montana**

July 8, 2016

### **Introduction**

There are three principal considerations in optimizing nutrient removal in municipal wastewater treatment plants: (1) personnel, (2) equipment, and (3) wastewater characteristics.

Educated, empowered, effective personnel can make the worst of treatment plants remove a remarkable amount of nitrogen and phosphorus. The corollary is also true: well-designed, well-constructed facilities will fail to effectively remove nutrients if they are ineffectively administered, operated, and/or maintained.

And, although low-strength wastewater is generally easier to treat conventionally, nutrient removal plants generally perform better with a high-strength influent.

### **Plant Background and Details**

It would be helpful to include a brief description of the plant treatment technology; schematic; current effluent concentrations and flow.

### **Optimization Strategies and Recommendations**

The Colstrip wastewater treatment plant is approximately 40 years old. The oxidation ditch was not designed for total-N or total-P removal, but there is no reason it cannot be operated in a fashion in order to reduce nutrients to very low concentrations.

To optimize nutrient removal, the following is recommended.

- (1) Cycle aeration equipment on and off in order to realize complete nitrification (effluent ammonia concentration of 0.5 mg/L or less) and effective denitrification (effluent nitrate concentration of 5 mg/L or less). To begin, turn the aeration equipment off for one hour each morning (Monday through Friday) and one hour during the afternoon. Monitor ORP at the end of the air-ON and air-OFF cycles. Extend the air-OFF cycles until an ORP value of -100 mV is achieved. The initial ORP target during the air-ON cycle should be +100 to +150 mV. As experience is gained, both targets should be refined.
- (2) Install ORP and/or nitrate probe(s) in the aeration tank and interconnect with SCADA (provide for trending charts) to monitor aeration tank conditions – and – program SCADA such that the ORP and/or nitrate data can be used to cycle the aerators and mixers on and off.
- (3) After observing how effectively the existing oxidation ditch can remove nitrogen, repair and upgrade existing equipment. And, instead of planning for its replacement, integrate its renovation into Colstrip's long-term facility upgrade planning to provide capital savings.
- (4) As plant staff develop an expertise in nitrogen removal, begin optimizing phosphorus removal by:

- a. Creating anaerobic conditions in the bottom layer of the ditch by extending air-off cycles and/or turning one or both of the mixers off during the air-off cycles
- b. And/or creating a sludge fermenter by turning the air off in the aerobic digester / sludge holding tank and returning a percentage of the fermented sludge to the oxidation ditch

Reconsider the following upgrade plans:

- (1) In lieu of installing air lift pumps in the new secondary clarifier, consider using mechanical pumps. Although plant staff has had good experience with the air lift pumps, the air used to pump RAS will, at times, bring more dissolved oxygen into the oxidation ditch than desired for optimal nitrogen removal. Also, mechanical pumps operating on VFDs and/or timers will provide better control of pumping rates. Finally, if the plant's air lift pumps are replaced with mechanical pumps, it may be possible to shut down the centrifugal blowers and realize considerable energy savings.
- (2) Consider renovations to the existing oxidation ditch. Notwithstanding its age, the process changes described above will likely demonstrate the validity of maintaining the ditch as the principal biological treatment process for decades to come.

## **Personnel**

The enthusiasm, knowledge, and level of teamwork evident in Colstrip – both at the plant and “downtown” – indicate that staff are fully capable of optimizing nutrient removal. With time, as staff gains operating experience, there is little doubt that they will be able to effectively optimize their treatment facility in order to attain impressive nutrient removal results.

With some process changes, and resulting improvements in nitrogen removal, staff will likely appreciate how well suited their 40-year old facility is to nutrient removal. And, as a result, will find it in their interest to restore what is now a rather derelict facility.

## **Equipment**

Colstrip's wastewater treatment facility may look neglected but it is not. Thanks to local creativity, several practical improvements have been made. The out-of-service mechanical aerators (rotors) have been replaced with floating aeration equipment. Plant staff installed piping to redirect the influent in order to reduce settling and improve treatment. And, thanks to the in-house talents of Colstrip's DPW Director Bryan Swan, in-line probes connected to the in-house programmed SCADA system have been installed, including a TSS probe in the aeration tank and a sludge depth transducer in the secondary clarifier. Colstrip staff are not only encouraged to continue their optimization efforts but are encouraged to demonstrate the pride that they have in their facility by updating and making permanent some temporary and “make-do” fixes.

Working with a consulting firm, Colstrip is undertaking a multiple-phased facility upgrade. Given the need to address some existing safety and process issues, it may be wise to reconsider the work elements to be undertaken in the first phase. Two safety concerns meriting attention were observed during a June 22, 2016 plant visit: safety cabling around the aerobic digester (at

best, a poor means of protection) was disconnected and a manhole near the headworks is equipped with an unsafe cover. As to treatment, prior to disinfection, a noticeable percentage of effluent is leaking through a diversion structure and bypassing UV disinfection. It probably makes sense to address these and other high priority issues that city staff may have during the first phase of the plant upgrade.

### **Wastewater Characteristics**

Influent wastewater appears to be amenable to treatment, including nutrient removal.

### **Next Steps:**

Moving forward, the following are recommended goals:

1. Contact Chief Operator John Stanich and arrange a visit to the Hardin wastewater treatment facility ([wwtp@hardinmt.com](mailto:wwtp@hardinmt.com); (406) 679-2199). By cycling the oxidation ditch rotors, Hardin has reduced effluent total-N to 4 mg/L from 18 mg/L.
2. Contact Chinook Chief Operator Eric Miller ([mt\\_dud@hotmail.com](mailto:mt_dud@hotmail.com); (406) 357-3160) to see how Colstrip might benefit from his success with optimizing phosphorus removal in an oxidation ditch by allowing enough of the mixed liquor to settle in the ditch during the air-OFF cycle to create anaerobic conditions for biological phosphorus removal.
3. Develop process control targets such as:
  - a. Oxidation ditch ORP during the air-ON cycles
  - b. Oxidation ditch ORP during the air-OFF cycles